TESTING WHEAT FOR QUALITY

By Byron S. Miller and John A. Johnson

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TESTING WHEAT FOR QUALITY[1]

By Byron S. Miller, *chemist, Crops Research Division, Agricultural Research Service,* and John A. Johnson, *professor, Department of Flour and Feed Milling Industries, Kansas State College*

Few people realize the complexity of wheat quality and how many different factors are entailed. To simplify the discussion, only the hard red winter and hard red spring wheats will be considered. They contain a relatively large amount of protein essential for good bread. Of the total amount of wheat produced in the United States, 65 percent is bread wheat; of the total amount, 50 percent is hard red winter and 15 percent hard red spring. Both are excellent, although the quality may vary widely in each.

Quality Characteristics Desired by the Farmer, Miller, and Baker

The farmer, miller, and baker desire some of the same quality characteristics in wheat, but each emphasizes different ones. The farmer wants a wheat that yields well, is resistant to drought, diseases, and other scourges, and has good test weight. He also desires the same quality characteristics that the miller and baker demand, because he is dependent on them for a market.

The miller considers that a good wheat for milling should have normal bolting, or sifting, properties. The flour should flow freely without a tendency to agglomerate. A very hard wheat requires extra power to grind and an elaborate milling procedure. A very soft wheat also requires alteration of the mill flow to reduce the quantity of break flour. Since commercial mills grind blends of different wheats, the flow must be adjusted to obtain the best yield from most of the components. The mill cannot be adjusted to obtain the most flour from a problem variety if that variety is not a major part of the wheat mix. A good hard wheat for milling provides from 69 to 75 percent of a 95-percent straight-grade flour with acceptable ash.

A good flour for baking should have high absorption, a medium dough-development time, and good mixing tolerance. The dough should be elastic and stable during the entire baking process. The resulting bread should have good crumb color, grain and texture, and loaf volume. Although all these quality characteristics are desirable, few wheats have all of them.

Ponca, a hard red winter wheat, and Thatcher, a hard red spring wheat, have many of the quality characteristics desired by the miller and baker. Pawnee and Wichita, which together comprised 50 percent of the

[1] Cooperative studies by the former Field Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station.

total wheat production in Kansas in 1955, are also desirable hard red winter wheats, but their main disadvantage is that they are too abundant. Pawnee has a short and Wichita a medium dough-development time, and generally they are blended with varieties having a longer dough-development time to meet bakers' specifications.

Since commercial bakers buy approximately 90 percent of the bread flour, their demands exert a powerful influence on wheat requirements. These bakers have been able to demand more and more strict specifications for the flour they purchase because of the high competition in the milling industry. This demand has forced the millers to search for and often to pay premiums for wheat that they need to meet the specifications of their bakery customers. Finally, this demand for flour specifications by the bakers creates a demand for the farmers to grow wheat varieties with characteristics that the millers want. Since new varieties are being released periodically, much testing and elimination must be done to furnish varieties that will meet the needs of millers and bakers. This experimentation may be rather difficult, because during the 12 to 15 years required to breed, develop, and release a new wheat to the public, commercial demands may change.

Tests for Quality

In both the hard red winter and hard red spring wheat areas, extensive quality testing is performed in Federal and State laboratories supplemented by collaborative testing in commercial laboratories before release of new wheats to farmers. This safeguards the interests of the milling and baking industries. Recently a promising hard red spring wheat was developed with good resistance to rusts, particularly to the 15B race of stem rust that seriously threatens hard red spring wheat production. However, it was never released, because quality tests by collaborators and others showed that the flour has poor handling characteristics and is easily damaged by overmixing. Conversely a hard red winter wheat selection, known as C. I. 12406, was found to have good quality characteristics for milling and baking, but it is susceptible to loose smut, soil-borne and streak mosaics, and stem rust. Therefore, it was not released.

Tests for quality can be divided roughly into the four following categories: Physical tests performed on grain, and chemical, physical dough, and baking tests performed on flour. All of them evaluate important quality characteristics related to the use of wheat for human consumption.

Physical Grain Tests

Physical tests for studying wheat quality are widely used. Test weight is one of the oldest. It is important to the farmer because wheat is bought and sold on a weight-per-bushel and grade basis. Wheats of high test weight bring more money to the farmer than those of low test weight. Test weight is also important to the miller, because flour yield usually is related to weight per bushel. Kernel shape, moisture content, wetting, subsequent drying, and even handling affect test weight, because they control the extent of packing of the grain. Thus, the relationship between test weight and flour yield may lose significance under certain conditions.

Low test weight due to shriveled kernels may add to the problems of manufacturing and storing flour. Shriveled wheat is more difficult to mill into a low-ash flour with desired "dress," or freedom from bran and germ specks. Such flour may not keep well, because the presence of germ causes the development of rancidity with storage.

The grade of wheat is important to the farmer, miller, and baker. The United States grain standards were designed by the United States Department of Agriculture to provide information, by means of market grades, to enable buyers to purchase grain for a given use. Grain is inspected and graded by licensed inspectors, who work under Federal supervision. The market grades, consisting of the numerical grades and the sample grade, specify for each class of wheat the minimum test weight and the maximum limits of damaged kernels, foreign materials, and wheats of other classes. They also indicate the general market quality of the wheat. For a more exact classification of quality on the basis of end use, other tests not required by the grain standards must be employed.

Chemical Tests

Originally several flour constituents were regarded as contributors to flour quality. Now the tendency is to determine flour quality mainly by protein quantity and quality.

Because of the normal, direct relationship between protein content and loaf volume, much importance is attached to the determination of the total amount of crude protein in wheat and flour. Customarily data on protein content are made available to buyers of wheat and flour.

The quantity of protein can be determined easily by the Kjeldahl procedure. The sample is heated in sulfuric acid until the protein is completely broken down and the protein nitrogen is transformed into ammonium sulfate. Then sodium hydroxide is added and the digest heated to drive the liberated ammonia into an acid of known concentration and quantity. The unused standard acid is determined, and the results are transformed by the application of a mathematical factor into the percentage of protein in the original weighed sample.

Another chemical test is the ash test, by which the total mineral content of wheat and flour is measured. A weighed sample is incinerated in a muffle furnace at 1100° F. overnight. The amount of mineral residue or ash is expressed as the percentage of the original sample.

In milling, the bran is separated from the endosperm and the endosperm is reduced to flour. Since the mineral content of bran is about 20 times that of endosperm, the ash test fundamentally indicates the purity of the flour or the thoroughness of the separation of bran and germ from the rest of the wheat kernel. It is important that bran and germ be separated from the endosperm, since they have deleterious effects on bread quality.

The ash test has assumed greater importance in the milling trade than any other test. Unfortunately its value in predicting flour quality has been greatly exaggerated. It is useful only in differentiation among flour grades. There has been too great a tendency to regard small differences in flour ash as being significantly related to flour quality.

Certain factors that are not related to the bran content may cause variation in the flour ash content. Among flours of comparable grades, high ash content is closely correlated with that of the wheat from which the flour was made. Thus, millers may not use wheat that is high in ash

even though it may have superior quality. Certain environmental conditions under which wheat is grown also affect the ash content of the flour. Usually high-protein flour has high ash content, yet high-protein flour demands a premium on the market. Thus, when flour ash is used as an indication of flour grade, sufficient consideration should be given to the intrinsic factors affecting the ash.

Certain chemical tests are valuable for judging quality because they supplement other quality tests. The amount of protein is the simplest and best single indicator of flour quality. The *quantity* of protein in wheat that is grown under favorable environmental conditions accounts for the major quality differences. However, when wheat is grown under abnormal environmental conditions, the *quality* of the protein accounts for most of these differences.

Physical Dough Tests

For many centuries after the invention of leavened bread by the Egyptians, the only suitable method for testing dough was visual inspection. Shortly after 1900 several instruments were devised to measure objectively dough characteristics. Two of these, the Brabender farinograph and the National Swanson-Working mixograph, are widely used today.

The Brabender farinograph measures plasticity and mobility of dough that is subjected to gentle mixing at constant temperature. When a given quantity of flour is mixed with water in a farinograph, the amount of water required for optimum absorption by the dough is indicated on the farinogram (fig. 1) when the curve passes through the Brabender 500-unit line. In addition to determining the quantity of water required, the curve shows the dough-development time (amount of mixing) needed to develop the dough properly for the best bread. It also shows the characteristics of the dough when it is mixed. If the curve falls off rapidly after reaching a peak, the dough has little stability to overmixing. Stability is the time difference to the nearest one-half minute between the point where the top of the curve first intersects the Brabender 500 line and the point where the top of the curve leaves this line. Another measurement used commercially to indicate the characteristics of flour during mixing is the mixing tolerance index (MTI). It is the difference vertically in Brabender units from the top of the curve at the peak to the top of the curve measured 5 minutes after the peak is reached.

Cheyenne, Comanche, Concho, Nebred, Ponca, Tenmarq, and some Turkey wheats usually exhibit good stability to mixing (top curve, fig. 1); Kanred, Kiowa, Triumph, and Wichita wheats show intermediate stability (middle curve, fig. 1); and Blackhull, Chiefkan, Pawnee, and RedChief wheats lack stability (lower curve, fig. 1).

Numerous factors other than the variety of wheat affect the characteristics of flour, as indicated on the farinogram. As the protein content increases, the absorption, dough-development time, and stability also increase, but the mixing tolerance index decreases. The miller considers all these characteristics when he selects and blends wheat to produce a flour that will meet the bakers' specifications.

Stability to mixing is the flour characteristic in great demand by commercial bakers. This demand is troublesome to millers, because only flour with a long dough-development time exhibits good tolerance to

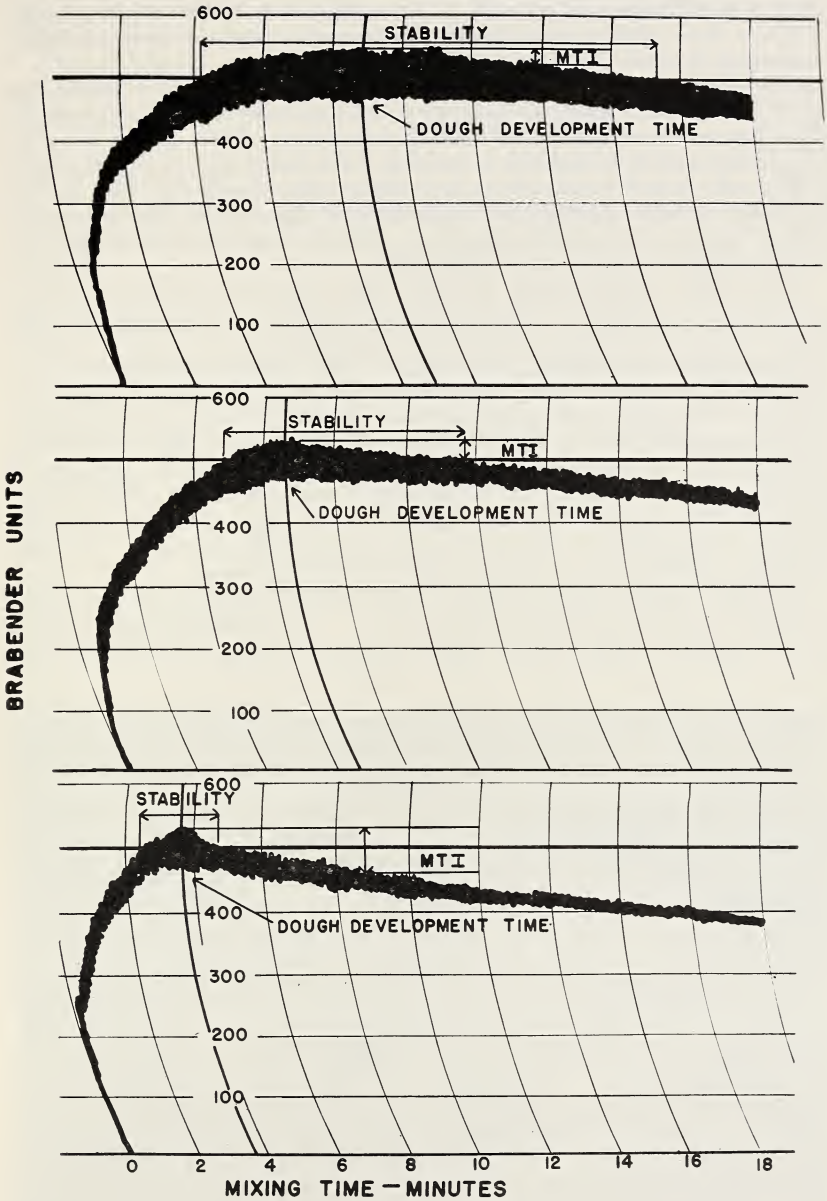

FIGURE 1.—Typical farinograms of flour samples with a long, medium, and short dough-development time, showing values for stability and mixing tolerance index (MTI).

mixing and frequently it is in short supply. Actually bakers would prefer a flour with a short dough-development time and good stability to mixing, because it would require less power to mix.

The conclusion should not be drawn that wheat varieties producing flour with a short dough-development time are inferior. Pawnee wheat flour has excellent quality for baking, but it has a short dough-development time and little stability to mixing. If a baker were to receive flour milled only from Pawnee wheat, he could produce excellent bread, but he would have to be careful how he handled the flour. He would have to mix it only to its peak development. If he overmixed it, certain quality characteristics of the bread would suffer.

The other dough-testing machine, the National Swanson-Working mixograph, is a miniature high-speed dough mixer. As the gluten of the flour develops in mixing, a gradually increasing force is required to push the revolving pins through the dough. This force is measured by the rotation of the bowl, which is placed in the center of a lever system. A record of the torque produced on the lever system is made on a mixogram. The mixograph gives a good estimate of the mixing time, and wheat varieties have a characteristic mixographic pattern. This machine is being used more and more at terminal elevators to classify wheat before binning. The upper curves in figure 2 are typical for Cheyenne and Pawnee wheat flours. The two lower curves show the effect of severe weather conditions on the same varieties during ripening.

Physical dough-testing machines also measure dough characteristics during a short period of the baking process. The machines do not replace the baking test but may be used to provide precise information on

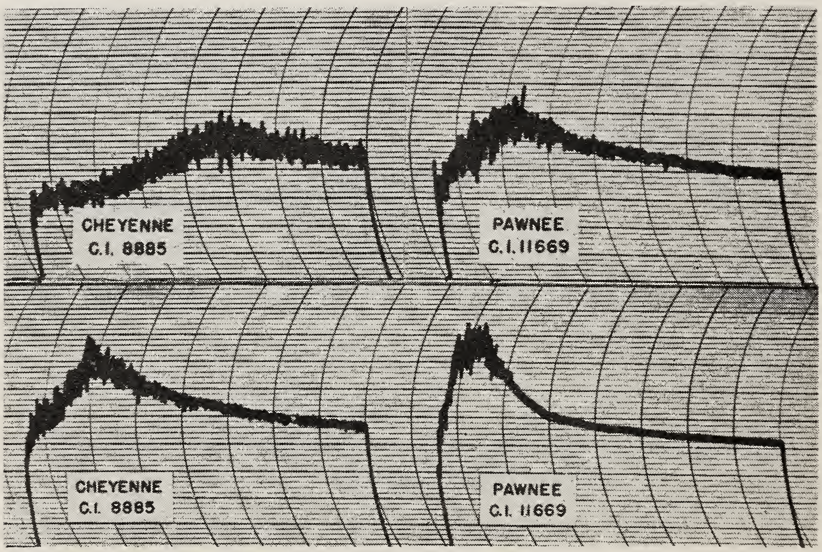

FIGURE 2.—Mixograms of flour samples showing the effect of environment on Cheyenne and Pawnee wheat grown at Lincoln, Nebr., (top) and at Clovis, N. Mex., (bottom). (Courtesy of Karl F. Finney, Federal Hard Winter Wheat Quality Laboratory, Manhattan, Kans.)

specific characteristics that cannot be obtained by other means. The baker frequently can use this information advantageously.

Physical dough tests that measure objectively the characteristics that are affected by variety and growing conditions are most valuable. By identifying known varieties with known quality characteristics for baking, the quality of the flour often can be predicted rather accurately. In addition, these tests may show differences in quality characteristics for flours with essentially the same baking quality. Bakers frequently employ dough-testing methods to check the uniformity of flour, which is important when they need a flour with specific physical dough characteristics.

Baking Test

The quality of baked bread is the final criterion for judging flour quality. In the baking test the percentage of absorption, loaf volume, and external and internal loaf characteristics are evaluated. In addition, the dough-development time, mixing tolerance, oxidation requirement, and fermentation tolerance can be determined by baking the same flour with different mixing and fermentation times and different levels of oxidant. However, one must be careful in interpreting the results, because the effects of excessive mixing or fermentation are similar to the effects of overoxidation. To produce an optimum loaf of bread all these variables must be in balance. Such a balance can be determined only by the baking test.

Generally the baking test is performed with 100-gm. samples of flour. When necessary, 291-gm. samples, which are equivalent to the regular commercial 1-pound loaves, may be used. Because of the demand for testing samples early in the wheat-breeding program, a micro test requiring only 8 gm. of flour was developed. (Fig. 3.)

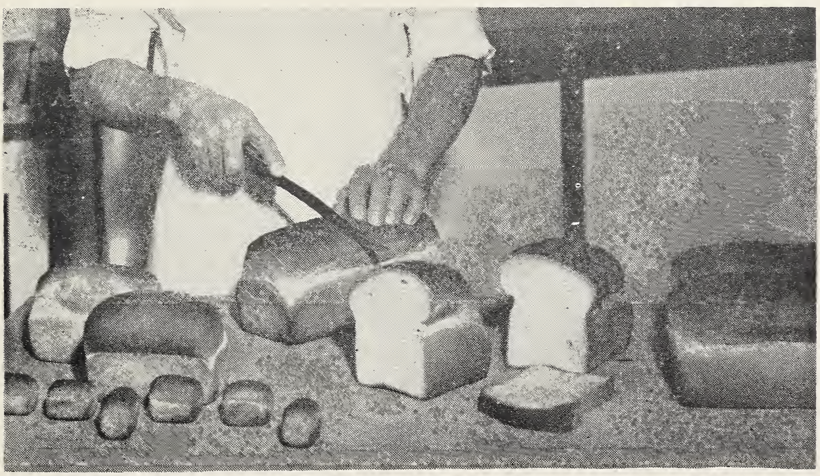

Figure 3.—Loaves of bread made from 8, 100, and 291 gm. of flour. The largest loaves are the commercial 1-pound size.

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In the baking test the straight- and the sponge-dough basic procedures are employed. In the straight-dough procedure all the ingredients are mixed in one operation. These include flour, water, yeast, salt, sugar, milk, shortening, enzyme supplement, and yeast food. During the primary fermentation the dough is punched to remove the gas, allowed to stand, and repunched. After a short rest period the dough is molded, panned, proofed, and baked. The sponge-dough procedure is similar to the straight-dough method, but the dough is prepared in two distinct operations. First, a sponge containing all the yeast but approximately 60 percent of the flour and water is mixed and fermented. After 3 to 5 hours the sponge is mixed with the remaining ingredients. After a short rest period the dough is molded, panned, proofed, and baked.

The straight-dough procedure is generally used in laboratory testing, but the sponge-dough procedure is used for pilot-plant testing and in commercial practice. The bread scores and loaf volume are highly correlated in the two methods. Since test procedures should approach closely those used commercially for bread production, the trend has been to follow the sponge-dough method to test breadmaking quality. Generally the intended use of the flour must be known before a satisfactory interpretation can be made of any baking test.

Quick tests to evaluate baking quality are desired. Several already are available that measure some of the important factors related to wheat quality. However, there still is no inexpensive device, requiring a small sample and little time, that interprets baking performance in general.

Premiums Paid for Some Wheat

Premiums usually are paid for wheat when it is in demand and in short supply. This demand among bread varieties generally has been for wheat with high protein content and/or good mixing tolerance. Frequently premiums have been paid for protein content only, although a few elevators and mills also have been willing to pay extra for such hard red winter wheats as Cheyenne, Comanche, Nebred, and Ponca and such hard red spring wheats as Lee, Marquis, Rushmore, Selkirk, and Thatcher, all of which have good mixing tolerance.

Elevators do not have facilities for evaluating protein quantity and quality. Furthermore, they have difficulty in binning and shipping separately high-quality wheat unless the farmer stores his wheat on the farm until the rush season is over. Since protein quantity and quality are not pricing factors at local elevators, local shipping points are usually classified early in the season according to the characteristics of the major portion of the wheat shipped from these points. Price differences naturally arise and are related to these characteristics. As the season progresses these differences may be altered because of changing demands or because the good wheat is mixed with inferior wheat, which may be trucked into and sold in the high-quality areas.

For example, at Bird City, Kans., from July 1954 to April 1955, wheat sold for as much as 15 cents and averaged 12¾ cents per bushel more than wheat of comparable grade and protein content from southwestern Kansas. For the same period, wheat grown in the Imperial, Nebr., area sold for as much as 31 cents and averaged 20½ cents per bushel more than wheat of the same grade and protein content grown in southwestern

Kansas. These price differentials reflect general or assumed quality differences on an area basis. They are due largely to varietal differences and the effect of adverse weather conditions on protein quality.

Improvement of Wheat Quality

In August 1955 the United States Department of Agriculture designated 24 varieties of wheat as undesirable and announced that in 1956 the seller would be docked 20 cents per bushel under the Government price-support program. This action should result in similar reductions in market prices for these wheats. In 1955, 3 percent of the total wheat production was devoted to these varieties.

Desirable varieties of hard red winter wheat with a long dough-development time include Cheyenne, Comanche, Concho, Nebred, Ponca, Tenmarq, and certain Turkey selections. Desirable varieties with a shorter dough-development time include Kiowa, Pawnee, Triumph, and Wichita. Among hard red spring wheats, Lee, Rushmore, Selkirk, and Thatcher have a long dough-development time and excellent general quality.

Since the average support price will be the same and some wheat will be docked 20 cents per bushel, the good varieties will be given a slight premium. This premium, even though small, should encourage the farmer to grow wheats of high quality.

The demand is for varieties with a long dough-development time, such as Comanche and Ponca. However, if everyone grew these varieties, they would become too abundant. Under these conditions smaller price differences would be expected. The miller, to meet bakers' specifications, must have the opportunity to choose wheats with a wide range of characteristics.

Table 1 shows that from 1929 to 1944 approximately 50 percent of the total wheat acreage in Kansas was devoted to varieties with a long dough-development time. This percentage then decreased sharply, and in 1954 only 17 percent of the acreage was occupied by these desirable wheats. During the next 2 years this percentage gradually increased. In 1956 the percentage of the acreage in Kansas devoted to varieties with a long, medium, and short dough-development time was approximately 33, 46, and 21, respectively. Only an approximate classification of varieties can be made on the basis of dough-development time, especially when differentiating between those varieties with a medium and those with either a long or a short dough-development time.

Many believe that varieties with a long dough-development time should represent 50 percent of the total wheat acreage. The trade has indicated that as much as 75 percent of the wheat grown should be of the varieties with a long dough-development time. This sharp increase in estimated demand has been due to adverse environmental factors, which frequently cause wheats with a long dough-development time to have a medium or even a short dough-development time. This condition has been particularly acute in Kansas.

Although the varieties with a long dough-development time in Nebraska (table 2) did not represent so high a percentage in 1955 and 1956 as they did in 1944, they still accounted for 57 percent of the total wheat acreage. The varieties with a medium dough-development time made up a rather minor part of the wheat acreage, but those with a short dough-development time, mainly Pawnee, made up 35–40 percent of the total in 1956.

TABLE 1.—*Percentage of the total wheat acreage occupied by each variety in Kansas at 5-year intervals, 1929–49, and annually, 1951–56*

Item	1929 [1]	1934 [1]	1939 [1]	1944 [1]	1949 [1]	1951 [2]	1952 [2]	1953 [2]	1954 [3]	1955 [2]	1956 [2]
DESIRABLE VARIETIES WITH—											
Long dough-development time:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cheyenne	......	......	0.2	0.8	0.6	0.5	0.7	0.7	0.9	1.1	2.2
Comanche	......	......	......	.1	20.8	16.8	16.9	13.7	11.1	12.7	15.3
Nebred	......	......	......	.1	......	......	......	......	.1	.4	.4
Ponca	......	......	......	......	......	......	......	......	2.4	6.8	12.6
Tenmarq	......	1.3	19.6	36.6	8.5	4.4	3.7	3.1	2.2	2.0	2.1
Turkey	48.0	44.3	28.9	14.7	1.7	.9	.7	.4	.3	.2	.3
Total	48.0	45.6	48.7	52.3	31.6	22.6	22.0	17.9	17.0	23.2	32.9
Medium dough-development time:											
Kanred	12.0	10.4	4.5	2.7	.2	.1	.1	......	......	......	......
Kiowa	......	......	......	......	......	......	.6	4.3	8.1	11.5	15.6
Triumph	......	......	......	.1	6.4	7.2	5.4	7.3	7.4	7.8	9.3
Wichita	......	......	......	......	9.4	16.8	16.6	19.7	24.3	25.0	21.2
Total	12.0	10.4	4.5	2.8	16.0	24.1	22.7	31.3	39.8	44.3	46.1
Short dough-development time:											
Blackhull	33.4	34.9	31.0	15.5	3.6	1.4	1.2	.7	.5	.3	.2
Pawnee	......	......	......	......	36.0	38.7	37.5	34.7	29.0	24.2	18.2
Total	33.4	34.9	31.0	15.5	39.6	40.1	38.7	35.4	29.5	24.5	18.4

UNDESIRABLE VARIETIES WITH—											
Short dough-development time:											
BlueJacket	......	......	......	......	.7	4.1	6.0	4.6	3.3	1.7	.3
Chiefkan	......	......	2.8	8.6	1.3	.6	.9	.7	.5	.3	......
Early Blackhull	......	.6	1.6	9.0	4.6	1.5	.7	.6	.5	.3	......
RedChief	......	......	......	4.4	3.9	5.4	6.9	6.2	6.1	3.1	.6
Total	......	.6	4.4	22.0	10.5	11.6	14.5	12.1	10.4	5.4	.9
Other varieties [4]	6.6	8.5	11.4	7.4	2.3	1.6	2.1	3.3	3.3	2.6	1.7
Grand total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Clark, J. A., and Bayles, B. B. DISTRIBUTION OF THE VARIETIES AND CLASSES OF WHEAT IN THE UNITED STATES IN 1949. U. S. Dept. Agr. Cir. 861, 71 pp. 1951.

[2] United States Agricultural Marketing Service and Kansas State Board of Agriculture. KANSAS WHEAT VARIETY SURVEY. Topeka, Kans. 1951–53, 1955–56. [Processed.]

[3] Salmon, S. C., and Reitz, L. P. DISTRIBUTION OF THE VARIETIES AND CLASSES OF WHEAT IN THE UNITED STATES IN 1954. U. S. Dept. Agr. Handb. 108, 86 pp. 1957.

[4] Include BlueJacket, Early Pawnee (Selection 33), KanKing, KanQueen, NewChief, RedJacket, Stafford, Yogo, and wheats of other classes grown in the hard red winter wheat area, as durum, soft red winter, and white. Also included is a small percentage of hard red spring wheat.

TABLE 2.—*Percentage of the total wheat acreage occupied by each variety in Nebraska at 5-year intervals, 1929–49, and annually, 1950–56*

Item	1929 [1]	1934 [1]	1939 [1]	1944 [1]	1949 [1]	1950 [2]	1951 [2]	1952 [2]	1953 [2]	1954 [3]	1955 [2]	1956 [2]
DESIRABLE VARIETIES WITH—												
Long dough-development time:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cheyenne	......	1.2	14.8	22.7	25.2	22.6	26.4	20.0	22.3	27.5	27.1	25.4
Comanche	......	......	......	......	.2	1.1	.7	1.0	1.8	.6	.9	1.0
Nebred	......	......	.2	15.3	26.1	22.4	19.6	25.0	32.5	26.6	24.0	27.4
Ponca	......	......	......	......	......	......	......	......	......	.2	......	......
Tenmarq	......	......	.2	2.8	1.4	1.9	1.1	1.0	1.2	.5	1.3	......
Turkey	68.2	59.5	58.0	43.4	7.8	10.7	6.7	4.0	3.9	2.7	4.1	3.0
Total	68.2	60.7	73.2	84.2	60.7	58.7	54.5	51.0	61.7	58.1	57.4	56.8
Medium dough-development time:												
Kanred	13.5	8.7	2.4	.8	.3	......	......	......	......	.2	......	......
Triumph	......	......	......	......	.1	......	......	......	......	.3	......	......
Wichita	......	......	......	......	.2	......	......	1.0	3.0	1.5	3.5	3.4
Total	13.5	8.7	2.4	.8	.6	......	......	1.0	3.0	2.0	3.5	3.4
Short dough-development time:												
Blackhull	.6	1.2	6.2	4.8	1.7	......	......	......	.6	.2	1.4	......
Pawnee	......	......	......	.3	33.4	36.6	39.2	41.0	30.9	35.7	33.4	35.5
Total	.6	1.2	6.2	5.1	35.1	36.6	39.2	41.0	31.5	35.9	34.8	35.5

UNDESIRABLE VARIETIES WITH—												
Short dough-development time:												
Chiefkan	......	......	.1	.2	.4	.2	......	.9	.2	.2	......	......
Early Blackhull	......	......	......	......	.4	......	......	......	......	......	......	......
RedChief	......	......	......	......	......	.7	.8	.7	.8	......	.4	......
Total	......	......	.1	.2	.8	.9	.8	1.6	1.0	.2	.4	......
Other varieties [4]	17.7	29.4	18.1	9.7	2.8	3.8	5.5	5.4	2.8	3.8	3.9	4.3
Grand total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] See footnote 1, table 1.

[2] Donald J. Lehr, secretary, Nebraska Grain Improvement Association, College of Agriculture, Lincoln, personal communication.

[3] See footnote 3, table 1.

[4] See footnote 4, table 1.

TABLE 3.—*Percentage of the total wheat acreage occupied by each variety in Oklahoma and Texas at 5-year intervals, 1929–54*

Item	Oklahoma						Texas					
	1929 [1]	1934 [1]	1939 [1]	1944 [1]	1949 [1]	1954 [2]	1929 [1]	1934 [1]	1939 [1]	1944 [1]	1949 [1]	1954 [2]
DESIRABLE VARIETIES WITH—												
Long dough-development time:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cheyenne	......	......	0.7	4.0	2.0	0.8	......	......	......	1.5	0.5	0.5
Comanche	......	......	......	......	11.0	9.6	......	......	......	.3	11.3	10.6
Concho	......	......	......	......	......	.01	......	......	......	......	......	......
Nebred	......	......	......	......	......	......	......	......	......	......	.1	.1
Ponca	......	......	......	......	......	2.3	......	......	......	......	......	......
Tenmarq	......	......	10.0	40.3	3.6	1.7	......	0.2	6.7	30.9	7.6	2.0
Turkey	47.4	44.9	29.3	15.0	1.6	.6	51.4	51.6	37.7	21.6	1.4	.6
Total	47.4	44.9	40.0	59.3	18.2	15.0	51.4	51.8	44.4	54.3	20.9	13.8
Medium dough-development time:												
Kanred	7.5	5.0	2.5	.7	.1	.1	19.8	16.1	6.0	6.9	1.3	.3
Kiowa	......	......	......	......	......	.4	......	......	......	......	......	.5
Triumph	......	......	......	1.3	41.5	40.5	......	......	......	......	17.1	17.1
Westar	......	......	......	......	1.2	9.5	......	......	......	......	26.0	20.0
Wichita	......	......	......	......	4.9	19.0	......	......	......	......	7.9	26.3
Total	7.5	5.0	2.5	2.0	47.7	69.5	19.8	16.1	6.0	6.9	52.3	64.2
Short dough-development time:												
Blackhull	34.2	32.0	36.6	16.9	1.9	.3	13.2	22.9	40.8	22.7	6.8	2.8
Pawnee	......	......	......	......	18.9	4.8	......	......	......	......	2.3	.5
Total	34.2	32.0	36.6	16.9	20.8	5.1	13.2	22.9	40.8	22.7	9.1	3.3

UNDESIRABLE VARIETIES WITH—												
Short dough-development time:												
BlueJacket	......	......	......	......	......	2.7	......	......	......	......	......	5.4
Chiefkan	......	......	1.5	5.9	.8	.1	......	......	.4	5.7	.9	1.5
Early Blackhull	......	......	1.9	7.0	6.1	.7	......	......	.5	2.9	8.7	1.7
RedChief	......	......	......	3.5	5.0	5.0	......	......	......	1.1	.9	3.3
Total	......	......	3.4	16.4	11.9	8.5	......	......	.9	9.7	10.5	11.9
Other varieties [3]	10.9	18.1	17.5	5.4	1.4	1.9	15.6	9.2	7.9	6.4	7.2	6.8
Grand total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] See footnote 1, table 1. [2] See footnote 3, table 1. [3] See footnote 4, table 1.

From 1929 to 1944 the varieties with a long dough-development time in Oklahoma and Texas (table 3) made up approximately 50 percent of the total wheat acreage. Since 1944 this total has dropped to approximately 15 percent in 1954. The acreage occupied by varieties with a medium dough-development time has increased from roughly 5 percent prior to 1944 to approximately 65–70 percent in 1954. The varieties with a short dough-development time accounted for 15–20 percent of the total production in 1954.

Much is being done to improve the quality of wheat for bread. Because of the development and release of improved varieties and because of the farmers' interest in producing premium-quality wheat, the milling and baking industries can expect a steady improvement in the quality of hard red winter wheats. Hard red spring wheats have been consistently of good quality. The Federal and State Governments, crop improvement associations, other trade organizations, and various agencies are working to make a good product still better.

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